

## APPLICATION OF WASTE TYRE RUBBER IN CONSTRUCTION INDUSTRY

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### ABSTRACT

About 80 million tyres are part of 33 million vehicles manufactured in India. The disposal of these discarded tires is a major environmental concern worldwide. The waste tyres rubber is not easily biodegradable even after long-period of landfill treatment. The landfilling of waste tyre creates soil and water pollution, because the waste tyre rubber holds toxic and soluble components. Burning of tyres results in serious fire hazards and tire stockpiles also provide a breeding habitat for various pests. Therefore it is necessary to find out the alternative for consumption or disposal of the discarded rubber tyres. Waste tyre rubber has great potential in construction industry related applications. This waste utilization would not only be economical, but may also help protecting the environment. At the same time, the use of waste tyres rubber as a substitute for natural aggregates in concrete and asphalt mixtures represents a great advantage from the point of view of conservation of natural resources. Although waste tyre rubber provides one of the environmental friendly and economically viable products but still there is lack of awareness among the society that waste tyre rubber can be converted into a valuable product.

**KEYWORDS:** Asphalt Mixture, Concrete, Precast Concrete, Waste Tyre Rubber

### INTRODUCTION

It is estimated that 1.2 billions of waste tyre rubber produced globally in a year. About 80 million tyres are part of 33 million vehicles manufactured in India (Sharma, 2010). The disposal of these discarded tires is a major environmental concern worldwide. Tire landfilling a common method for disposing of waste tyre rubber, is responsible for a serious ecological threat.



**Figure 1: Burning of Tyres during Stockpiles**

It is estimated that 11% of postconsumer tyres are exported and 27% are sent to landfill, stockpiled or dumped illegally (Vadivel and Thenmozhi, 2012). The waste tyres rubber is not easily biodegradable even after long-period of landfill treatment (Segre and Joekes, 2000). The landfilling of waste tyre creates soil and water pollution, because the waste

tyre rubber holds toxic and soluble components. It also provides a breeding habitat for various pests. Burning of tyres results in serious fire hazards as shown in Figure 1. Therefore it is necessary to find out the alternative for consumption or disposal of the discarded rubber tyres. Waste tyre rubber can be used in construction industry.

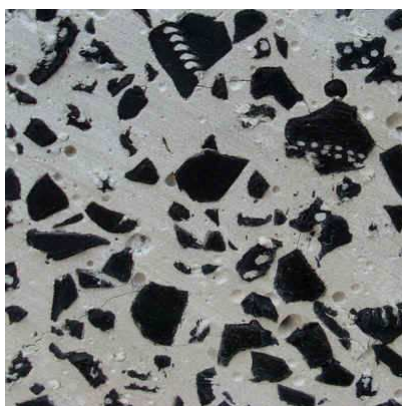
Many researches use waste tyre rubber as aggregates in concrete and studied its mechanical and durability properties. (Ganesan et al., 2012) investigate the strength and durability characteristics of self compacting rubberised concrete with and without the addition of fibres. The reduction in compressive strength due to the incorporation of scrap rubber in self compacting concrete could be compensated to some extent by the addition of steel fibres. The rubberised concrete with fibres was seen to have the best resistance against abrasion. Self compacting rubberized concrete may be a useful cementitious composite with better durability characteristics than conventional self compacting concrete. (Mavroulidoum and Figueiredo, 2010) concluded that concrete with rubber aggregate contents higher than 10% by mass would be unacceptable for primary structural elements. However there are a number of structural applications of medium to low strength requirements for which blocks or other precast concrete units and have the advantage of a lower unit weight over usual concrete mixes. (El-Gammal et al., 2010) found that although, there was a significant reduction in the compressive strength of concrete utilizing waste tire rubber than normal concrete, but concrete utilizing waste tire rubber demonstrated a ductile, plastic failure rather than brittle failure. (Wakchaure and Chavan, 2014) concluded that using waste tyre crumb rubber particle replaced to fine aggregate in concrete at 0.5 % and 1.0% showed no effect on compressive, flexural and split tensile strength of concrete. Using waste tyre crumb rubber with 1.5 % and 2.0% replacement affects the hardened concrete properties. The reduced strength was recovered by adding the glass fiber to the weight of cement by 0.4% for 1.5% replacement and 0.5% for 2.0% replacement of crumb rubber to the weight of fine aggregate in concrete. (Azmi et al., 2008) reporting that there was an increasing in slump value when crumb rubber content increased from 0% to 30%. It means crumb rubber concrete mixes exhibits an acceptable workability in term of ease of handling, placement and finishing with respect to normal concrete. (Balaha et al., 2007) found that concrete composites containing waste tyre rubber shows high toughness and having a high energy absorption capacity as compare to normal concrete. (Fioriti et al., 2007) mentioned that concrete paving blocks containing 8% of tyre rubber waste have a resistant impact of almost 300% when compared to the reference concrete. (Skripkiunas et al., 2007) reporting that static and dynamic modulus of elasticity of crumb rubber concrete was lower than normal concrete but crumb rubber concrete has an ability to withstand large deformation as compare to normal concrete. (Kettab and Bali, 2004) studied that when rubber (particle size <2 mm) is added to asphalt mixtures, the compaction and strength characteristics are improved as the rubber fills the existing voids within the granular skeleton. (Punith et al., 2002) examined the tensile strength characteristics of Dense Bituminous Macadam (DBM) mixes with crumb rubber and found that rubberized DBM mixtures are expected to have a longer life than the conventional DBM mixture. (Tortum et al., 2005) studied the effects of tyre rubber and aggregate gradation, mixing and compaction temperature, tyre rubber and binder ratio, and mixing time on bituminous mixtures. They concluded that for specific conditions, rubberized asphalt mixtures performed better than the conventional mixture. (Mane et al., 2013) mentioned that 10% addition of rubber crumbs has best suitability for blending it with bitumen to use for road construction. This will help to dispose the waste tire rubber in a proper way and solve the problem of environmental concerns up to a certain extent.

From above it is clear that waste tyre rubber is a promising material in the construction industry. This waste utilization would not only be economical, but may also help protecting the environment. Different applications of waste tyre rubber in construction industry are as follows:

## DIFFERENT APPLICATION OF WASTE TYRE RUBBER

### Waste Tyre Rubber in Concrete

Waste tyres have been used to partially replace the aggregates in concrete. Rubberized concrete are very weak in compressive and tensile strength. But they have very good deformation properties. Concrete with tire rubber waste has higher set deformations than non rubberized concrete. Ultimate strains on concrete failure load are higher for concrete with tyre rubber waste additive. Due to this, rubberized concrete provides high impact resistance. This behavior is beneficial for structures which require good impact resistance properties. A typical image of rubberized concrete using shredded old tyres is shown in Figure 2.



**Figure 2: Rubberized Concrete Using Shredded Old Tyres**

The durability of a material is often related to its capacity to resist water absorption. Rubberized concretes have good water resistance with low water absorption. Thus, rubberized concrete provides better durability properties than normal concrete. Rubberized concrete has excellent freeze-thaw characteristics. Due to this, expansion/contraction was cut in half, and thus cracking, was reduced. Rubberized concrete can be used in non load bearing members such as lightweight concrete walls, building facades, or other light architectural units. The other viable applications well suited for use in areas where repeated freezing and thawing occur, and can also be poured in larger sheets than conventional concrete.

### Waste Tyre Rubber in Precast Concrete

The use of waste tyre in precast concrete provides lightweight panels, which can be transported quicker and easier. These precast lightweight panels are nonconductor of both noise and electricity. Due to this, these panels are use in offices and houses as non-load bearing walls/ partition walls. Waste tyre rubber also use in precast roofs for green building due to its heat resisting property. Another application of waste tyre rubber in precast concrete is precast sidewalk panels. The use of waste tyre rubber in precast sidewalk panels makes it light weight and skid resistive. Now days all utility pipes – water, sewer, electrical, phone and TV cables are run under sidewalk. With precast sidewalk panels, we could simply lift them up when we need to get to the pipes to work on them.

### Waste Tyre Rubber in Asphalt Mixtures

Waste tyre rubber can be used as substitutes for natural aggregates or as bitumen modifiers in asphalt mixtures. There are two ways of producing rubberized asphalt mixtures viz. wet method & dry method. In the wet process, rubber particles are mixed with bitumen at elevated temperature prior to mixing with the hot aggregates; whereas in the dry process, rubber particles replace a small portion of the mineral aggregate in the asphalt mix before the addition of the

bitumen. The use of waste tyre rubber in asphalt mixtures reduces fatigue cracking, requiring less maintenance compared to conventional mixtures shown in Figure 3.



**Figure 3: (a) Rubberized Asphalt Pavement (10% Crumb Rubber Modified Test Section) without Cracking (b) Conventional Asphalt Pavement (Control Section) exhibiting cracking**

Rubberized asphalt mixtures have better skid resistance and longer pavement life compared with normal asphalt mixtures. Rubberized asphalt mixtures show better performance at high temperatures, they can be used in a variety of climate conditions and they are more flexible at low and sub-under zero temperatures. Rubberized asphalt mixtures also reduce the noise levels. Moreover, rubberized asphalt concrete is cost effective over conventional asphalt concrete.

### Other Applications

- Waste tyre rubber chips find application in geotechnical due to its low density and high shear strength. Tyre chips can be used with sand as a lightweight geomaterial for embankments or as backfill against retaining walls. These tyre chips are also cheaper as compared to other fill materials.
- Waste tyre rubber can be used as a shock absorber and earthquake shock-wave absorber in the building. It reduces plastic shrinkage cracking and reducing the vulnerability of concrete to catastrophic failure. Waste tyre rubber can also be used as sound absorber in sound barriers.
- The use of waste tyre rubber in play ground surface enhances its drainage capability and durability. It also provides a softer playing surface for children and athletes which reduces ground-related injuries.
- Shredded waste tyres can be used as fillers in roads, railway and construction developments. Finely shredded waste tyres can also be used as mulch (protective cover) which is long lasting and non-leachable. Colored rubber mulches are use in gardens and parks.
- Waste tyre can be used as an alternative fuel in cement industry to burn the cement kilns.

### CONCLUSIONS

Waste tyre rubber has great potential in construction industry related applications. This waste utilization would not only be economical, but may also help protecting the environment. At the same time, the use of waste tyres rubber as a substitute for natural aggregates in concrete and asphalt mixtures represents a great advantage from the point of view of conservation of natural resources. Although waste tyre rubber provides one of the environmental friendly and economically

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